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**1979 VIRUS TOLERANCE RATINGS
FOR CORN STRAINS
Grown in the Lower Corn Belt**

In cooperation with
Missouri Agricultural Experiment Station
Ohio Agricultural Research and Development Center and
Ohio Cooperative Extension Service

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Preface

In continuing research to measure corn tolerance to natural virus infection by maize dwarf mosaic and maize chlorotic dwarf, breeders and researchers grew selected corn strains in test plots in lower parts of the Corn Belt. The results of these tests are given in this publication in two parts—corn strains grown in Missouri and those grown in Ohio.

Observers of the individual corn plants rated symptoms on a scale from 1 (no virus symptoms) to 9 (complete susceptibility). Infections varied in intensity between hybrids and inbreds. At all test locations, johnsongrass, an alternate host, was abundant near the plots. The rating variations within tests of inbreds and single cross and double cross hybrids are shown in tables in this publication.

1979 Virus Tolerance Ratings of Corn Strains Grown in Missouri¹

Jack R. Wallin, Marcus S. Zuber, Larry L. Darrah, and Daniel V. Loonan²

This study identifies corn (*Zea mays* L.) strains evaluated in 1979 that exhibit various levels of tolerance to maize dwarf mosaic virus (MDMV) and maize chlorotic dwarf virus (MCDV). The results should be useful to growers for identifying hybrids with high tolerance levels suitable for planting in areas of high virus incidence. In addition, the results are useful to us in evaluating the response of new experimental strains that might be worthy of injecting into the corn improvement program.

We grew commercial corn varieties at two locations in Missouri where we noted MDMV and MCDV symptoms under conditions of natural infection. Test plots were located on the Bonacker Farm near House Springs, Jefferson County, and on the Delta Center Experimental Station, Portageville, Pemiscot County.

In 1979, 11 Mo17 sister-line crosses from various sources were planted May 9 in the Columbia Rollins' Bottom nursery, where they were

exposed to natural virus infection, apparently MDMV. Each sister-line cross occurred 12 times in a nonrandom systematic arrangement to facilitate hand pollination. Virus ratings for plants within each plot were averaged, and plot means were used in an analysis of variance.

Corn inbred lines, S₁ lines, single crosses, three-way, and double crosses were planted with a four-row plot planter in single-row plots consisting of 32 plants. We spaced plants 8¼" (21 cm) apart within each row and spaced rows 3 feet (91 cm) apart. Each plot was replicated two, three, or six times, depending on the experiment. The sister-line crosses in Rollins' Bottom were hand planted with about 1 foot (30 cm) spacings between plants and 3 feet (91 cm) between rows.

We delayed planting at House Springs until May 17 and at Portageville until May 10 because of adverse weather conditions and to encourage high levels of virus infection from johnsongrass (*Sorghum halpense* (L) Pers.), the alternate host for the corn virus strains involved here. Johnsongrass is abundant and grows about 6½ feet (2 m) in and around the test plots at both locations.

Virus incidence

MDMV and MCDV were identified by plant symptoms at both locations. MDMV produces a

¹Cooperative investigations between the U.S. Department of Agriculture, Science and Education Administration—Agricultural Research, and the University of Missouri Agricultural Experiment Station, Columbia, Journal Series No. 8522.

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Table 1.—Comparative virus ratings¹ for a susceptible and a tolerant single cross to virus infections for 12 years at two locations in Missouri

Location and single cross	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Avg.
House Springs (Jefferson County)													
Mo5xH55 (susceptible)	8.00	8.20	7.30	7.60	7.00	7.00	8.20	7.50	6.80	6.83	5.08	7.46	7.25
Mo4Wx0h7B (tolerant)	1.67	5.81	4.00	4.70	2.33	1.03	3.60	1.70	4.00	2.66	3.17	3.57	3.21
Portageville (Pemiscot County)													
Mo5xH55 (susceptible)	4.67	6.33	5.33	7.00	3.67	7.00	3.70	4.50	8.40	6.65	6.16	6.22	5.80
Mo14Wx0h7B (tolerant)	1.35	1.00	1.70	1.00	1.00	2.30	1.70	1.20	5.50	1.14	2.37	2.95	1.93

¹Rating scale from 1 (no symptoms) to 9 (death of the plant).

Table 2.—1979 virus ratings for 44 commercial, 2 check hybrids, and 4 sweet corn hybrids grown at House Springs, Jefferson County, Mo., planted May 17, rated August 21, 1979

Hybrid	Rating	OMRT ¹
Pfizer Genetics X830.82	3.48	
Mo14W x OH7B ²	3.57	
Pioneer Brand X7448	3.63	
Golden Harvest XC-605	3.91	
DeKalb XL394	3.92	
McCurdy 77-60	3.97	
Pioneer Brand 3145	3.99	
Pioneer Brand 3179	4.07	
Pioneer Brand 3147	4.19	
DeKalb XL72B	4.20	
Funk's G4787W	4.21	
Golden Harvest H-2745	4.22	
Cargill 951	4.29	
P-A-G 266010	4.34	
Funk's G4740	4.38	
Cargill EXP275004	4.42	
Funk's 28793	4.54	
McCurdy 77-51	4.57	
McCurdy 75-7870	4.59	
DeKalb XL72BB	4.61	
Acco AR72176	4.61	
McNair X233	4.77	
McNair 3276	4.83	
P-A-G SX346	4.96	
DeKalb EXP6000RT	4.96	
McCurdy 78-78	4.96	
NC+ 5288	5.02	
Cargill EXP275033	5.05	
Funk's G4848	5.07	
Acco UC9585	5.10	
McNair 3275	5.12	
McNair 488	5.12	
Pfizer Genetics MOM116	5.15	
O's Gold TX311	5.41	
NC+ 4222	5.42	
O's Gold SX3344	5.45	
Golden Harvest H2660W	5.51	
P-A-G SX17A	5.56	
P-A-G 266031W	5.61	
O's Gold SX5255	5.65	
Acco UC9902	5.77	
Acco AR81731	5.89	
NC+ 59	6.23	
NC+ 57	6.28	
O's Gold SX5353	6.58	
Northrup King Goldie (SC) ³	7.30	
Mo5X H55 ²	7.46	
Northrup King Sugar Loaf (SC)	8.00	
Northrup King Reliance (SC)	8.66	
Northrup King NK199 (SC)	8.81	
Coefficient of variation		18.0%
Least significant difference, P = 0.05		0.86
Mean rating.		5.15

¹ Duncan's Multiple Range Test--Entries with the same line in common are not significantly different at the 5 percent level.

² Check hybrids.

³ Sweet corn.

typical mosaic pattern, whereas MCDV produces vein clearing on infected leaves. Johnsongrass is an alternate host for both viruses. The corn leaf aphid (*Rhopalosiphum maidis* (Fitch)), the greenbug (*Schizaphus graminum* (Rondani)), and several other aphids are vectors for MDMV, which also can be transmitted mechanically. The leafhopper, *Graminella nigrifrons* (Forbes), is the vector of MCDV, which cannot be transmitted mechanically.

We noted each plant within a plot for virus

symptoms on a 1 to 9 severity scale, with 1 = no symptoms and 9 = death of the plant. The ratings were made mainly for severity and not for specific types of virus. The Uniform Test of Southern Inbred Lines was rated at about the 3-foot (91 cm) stage, and the mature plant stage, since MDMV symptoms were more easily detected in the early rating. The plot means used in analyses was the average of the individual plant ratings.

At Columbia, only MDMV symptoms were

noted on the Mol7 sister-line crosses and were so evaluated.

MDMV was the predominate virus at all locations. The 1979 average virus rating at House Springs for the tolerant single cross, Mol4WxOH7B (12-year average = 3.20), was 3.57, higher than 1978 (table 1). The susceptible single cross, Mo5xH55, rated 7.46, higher than in 1978 and higher than the 12-year average (6.63).

At Portageville, the 12-year average rating for

the tolerant cross (Mol4WxOH7B was 1.93, and the susceptible cross (Mo5XH55) was 5.80. The 1979 rating for the former was 2.95 and the latter 6.22.

Commercial hybrids

Virus ratings were made for 44 commercial dent corns, 4 sweet corns, and 2 hybrid checks at House Springs and Portageville (tables 2, 3, 4). At

Table 3.—1979 virus ratings for 44 commercial, 2 check hybrids, and 4 sweet corn hybrids grown at Portageville, Pemiscot County, Mo., planted May 10, rated August 9, 1979

Hybrid	Rating	DMRT ¹
Pfizer Genetics X83082	1.95	
McCurdy 78-78	2.54	
P-A-G SX17A	2.69	
P-A-G SX346	2.74	
McNair 3275	2.84	
Acco UC9585 ²	2.94	
Mol4W x Oh7B ²	2.95	
Pioneer 8rand X7448	3.00	
Cargill EXP 275004	3.01	
Golden Harvest H2745	3.05	
Pioneer 8rand 3145	3.09	
Funk's G4740	3.14	
Cargill 951	3.18	
O's Gold SX5255	3.22	
O's Gold SX3344	3.42	
Golden Harvest XC-605	3.48	
NC+ 5288	3.49	
McCurdy 77-51	3.51	
McCurdy 77-60	3.53	
NC+ 57	3.54	
Acco 72176	3.55	
McNair 488	3.58	
McNair X233	3.58	
Pfizer Genetics MDM116	3.74	
McCurdy 75-7870	3.77	
DeKalb XL728B	3.78	
Acco UC9902	3.79	
McNair 3276	3.85	
Acco AR81731	3.86	
Golden Harvest H-2660-W	4.06	
Pioneer 8rand 3147	4.08	
Funk's G4787W	4.15	
Pioneer 8rand 3179	4.24	
Funk's 28793	4.29	
DeKalb EXP6000RT	4.33	
Cargill EXP275033	4.37	
O's Gold SX5353	4.38	
DeKalb XL394	4.42	
NC+ 4222	4.45	
Funk's G4848	4.46	
O's Gold TX311	4.51	
P-A-G 266031W	4.67	
P-A-G 266010	4.79	
DeKalb XL72B	5.16	
NC+ 59	5.25	
Mo5 x H55 ²	6.22	
Northrup King Sugar Loaf (SC) ³	6.42	
Northrup King NK199 (SC)	6.79	
Northrup King Goldie (SC)	7.67	
Northrup King Reliance (SC)	7.95	
Coefficient of variation		25.9%
Least significant difference, P = 0.05		1.09
Mean rating.		4.04

¹Duncan's Multiple Range Test--Entries with the same line in common are not significantly different at the 5 percent level.

²Check hybrids.

³Sweet corn.

Table 4.—Combined 1979 virus ratings for 44 commercial, 2 check hybrids, and 4 sweet corn hybrids grown at House Springs and Portageville, Mo.

Hybrid	Ratings	DMRT ¹
Pfizer Genetics X83082	2.71	
Mo14W x Oh7B ²	3.26	
Pioneer Brand X7448	3.32	
Pioneer Brand 3145	3.54	
Golden Harvest H-2745	3.64	
Golden Harvest XC-605	3.69	
Cargill EXP275004	3.72	
Cargill 951	3.74	
McCurdy 77-60	3.75	
McCurdy 78-78	3.75	
Funk's G4740	3.76	
P-A-G SX346	3.85	
Acco UC9585	4.02	
McCurdy 77-51	4.04	
Acco AR72176	4.08	
P-A-G SX17A	4.12	
Pioneer Brand 3147	4.14	
Pioneer Brand 3179	4.17	
DeKalb XL394	4.17	
McNair X233	4.18	
McCurdy 75-7870	4.18	
Funk's G4787W	4.18	
DeKalb XL728B	4.20	
McNair 3275	4.21	
NC+ 5288	4.26	
McNair 3276	4.34	
McNair 488	4.35	
Funk's 28793	4.41	
O's Gold SX3344	4.44	
O's Gold SX5255	4.44	
Pfizer Genetics MDM116	4.45	
P-A-G 266010	4.57	
DeKalb EXP6000RT	4.64	
DeKalb XL72B	4.68	
Cargill EXP275033	4.71	
Funk's G4848	4.77	
Acco UC9902	4.78	
Golden Harvest H-2660W	4.79	
Acco AR81731	4.88	
NC+ 57	4.91	
NC+ 4222	4.94	
O's Gold TX311	4.96	
P-A-G 266031W	5.14	
O's Gold SX5353	5.48	
NC+ 59	5.74	
Mo5 x H55 ²	6.84	
Northrup King Sugar Loaf (SC) ³	7.21	
Northrup King Goldie (SC)	7.48	
Northrup King NK199 (SC)	7.80	
Northrup King Reliance (SC)	8.31	
Coefficient of variation		21.5%
Least significant difference, P = 0.05		0.98
Mean rating.		4.59

¹Duncan's Multiple Range Test--Entries with the same line in common are not significantly different at the 5 percent level.

²Check hybrids.

³Sweet corn.

House Springs, the lowest rating was 3.48 and the highest 6.58. Virus infection was greater and johnsongrass growth heavier than in 1978. In 1978, 37 hybrids rated 4.08 or less, and only 8 rated less in 1979. All sweet corns rated about 7.30. At Portageville, virus ratings were higher than in 1978, and the range was not as great as in 1978. In 1978, the ratings ranged from 1.81 to 5.76, while in 1979, they ranged from 1.95 to 5.25. In 1978, three entries rated 2.0 or less and only

one rated in 1979. Again in 1979, most hybrids could not be statistically differentiated, suggesting that commercial corn breeders are developing hybrids with increased tolerance levels. All four sweet corns rated 6.42 or higher.

Uniform test of Southern corn inbred lines

Ten inbred lines in the Southern Corn Improvement Conference Uniform Test were grown and

Table 5.—1979 virus ratings for inbred lines in the Southern Corn Improvement Conference Uniform Test grown on Bonacker's Farm near House Springs in Jefferson County, Mo., planted May 17

Inbred	Rating ²	DMRT ¹
T143	4.17	
T240	4.93	
Ga209	4.97	
Oh513	5.48	
MP490	5.69	
T232	5.82	
SC229	7.05	
TX601	7.06	
Mo43	7.95	
KY21	8.64	
Coefficient of variation		17.8%
Least significant difference, P = 0.05		1.21
Mean rating		6.18

¹Ouncan's Multiple Range Test--Entries with the same line in common are not considered significantly different at the 5 percent level.

²Six reps.

Table 6.—1979 virus ratings for PR-Mo2 lines grown at Portageville, planted May 10, rated August 9

Entry	Rating ¹	DMRT ²
5 (PR-Mo2(S ₁)C ₁) ³ (M-V)CO	3.01	
4 (PR-Mo2(S ₁)C ₁) ³ (M-V)CO	3.34	
B (PR-Mo2xMoSQA)(S ₁)C ₁	3.92	
3 (PR-Mo2xMoSQB)(S ₁)C ₁	4.07	
2 PR-Mo2(M-V)C ₁	4.11	
9 PR-Mo2(M-V)C ₂	4.47	
6 (PR-Mo2xMoSQB)unsel	4.58	
1 PR-Mo2 unsel	4.67	
7 (PR-Mo2xMoSQA)unsel	5.12	
10 REVOLUTION	5.57	
Coefficient of variation		16.3%
Least significant difference, P = 0.05		0.49
Mean rating		4.29

¹Six reps.

²Ouncan's Multiple Range Test--Entries with the same line in common are not considered significantly different at the 5 percent level.

³C₁ formed by random mating selected entries at two winter nurseries.

Table 7.—1979 virus ratings for PR-Mo2 lines grown at House Springs, planted May 17, rated August 21

Entry	Rating ¹	DMRT ²
4 (PR-Mo2(S ₁)C ₁) ³ (M-V)CO	4.11	
5 (PR-Mo2(S ₁)C ₁) ³ (M-V)Co	4.48	
6 (PR-Mo2xMoSQB)unsel	4.66	
9 PR-Mo2(M-V)C ₂	4.68	
1 PR-Mo2 unsel	4.84	
2 PR-Mo2 (M-V)C ₁	4.98	
3 (PR-Mo2xMoSQB)(S ₁)C ₁	4.99	
8 (PR-Mo2xMoSQA)(S ₁)C ₁	5.31	
7 (PR-Mo2xMoSQA) unsel	5.41	
10 REVOLUTION	7.01	
Coefficient of variation		10.5%
Least significant difference, P = 0.05		0.28
Mean rating		5.05

¹Six reps.

²Ouncan's Multiple Range Test--Entries with the same line in common are not considered significantly different at the 5 percent level.

³C₁ formed by random mating selected entries at two winter nurseries.

Table 8.—1979 combination virus ratings for PR-Mo2 lines grown at House Springs and Portageville, Mo.

Entry	Rating ¹	DMRT ²
4 (PR-Mo2(S ₁)C ₁) ³ (M-V)Co	3.72	
5 (PR-Mo2(S ₁)C ₁) ³ (M-V)Co	3.75	
3 (PR-Mo2xMoSQB)(S ₁)C ₁	4.53	
2 PR-Mo2(M-V)C ₁	4.54	
9 PR-Mo2(M-V)C ₂	4.57	
6 (PR-Mo2xMoSQB)unsel	4.62	
B (PR-Mo2xMoSQA)(S ₁)C ₁	4.62	
1 PR-Mo2 unsel	4.75	
7 (PR-Mo2xMoSQA)unsel	5.27	
10 REVOLUTION	6.29	
Coefficient of variation		13.3%
Least significant difference, P = 0.05		0.39
Mean rating		4.67

¹Six reps each location.

²Ouncan's Multiple Range Test--Entries with the same line in common are not considered significantly different at the 5 percent level.

³C₁ formed by random mating selected entries from trials done at two winter nurseries.

Table 9.—Virus ratings for Mol7 sister-line crosses grown in the 1979 Rollins' Bottom nursery

Sister-line cross	Mean virus rating	DMRT ¹
Mol7Ht x Mol7-231	2.71	
Mol7Ht x R2040	2.57	
Mol7Ht x L10	2.55	
Mol7 x Mo43	2.54	
Mol7Ht x FR20	2.49	
Mol7Ht x LH56	2.45	
Mol7Ht x LH55	2.39	
Mol7 x Mo40	2.38	
Mol7Ht x 1129-2	2.36	
Mol7Ht x LH24	2.28	
Mol7Ht x LH20	1.95	
Mean	2.43	

¹Means that are joined by the same line are judged not significantly different by Duncan's Multiple Range Test (DMRT) at $P = 0.05$.

rated at House Springs (table 5). The inbreds were rated first in July and then on August 21, 1979. The first rating was not included because the johnsongrass competition with the young plants was too great, and they needed more time to develop. The late rating included the composite symptoms of MCDV-MDMV. In the August rating for the virus complex, six inbreds T143, T240, GA209, Oh513, MP490, and T232 were significantly more tolerant than the others. They rated between 4.17 and 5.82, which was much higher than the 1978 ratings.

PR-Mo2 mass selections for virus tolerance

We rated nine derivatives of the composite corn strain PR-Mo2 for their response to MDMV and MCDV at House Springs and Portageville (tables 6, 7, 8). PR-Mo2(M-V)C2 has been mass selected where plants showing virus symptoms were eliminated before flowering for four generations. Data from House Springs and Portageville indicated that for unknown reasons, mass selection for virus tolerance under natural infestation has not been effective. This fact was evident when the first years' mass selection material, (PR-Mo2 (S1)C1) (M-V) CO ex 76-77, rated lower than PR-Mo2 (M-V) C2 that had been mass selected for 4 years. At both locations, the former rated more virus tolerance than the latter.

Mol7 sister-line crosses

The 11 Mol7 sister-lines were evaluated for what appeared to be MDMV infection. Since we found no johnsongrass in the immediate area, the MDMV strain B may be the causal virus.

We found significant differences between the 11 sister-line crosses with a coefficient of variation of 12.4 percent (table 9). Mol7Ht x LH20 had significantly lower virus rating than the other 10 sister-line crosses. The next eight entries were statistically indistinguishable. Mol7Ht x Mol7-231 has the highest virus rating.

Because of the nonrandom planting arrangement, a bias exists in the analysis, and the results should be interpreted with some caution. Generally, there appeared to be reasonable virus tolerance among the sister-line crosses. Selection in the segregating generation of Mol7Ht x LH20 may be warranted for a more virus tolerant Mol7 line.

Conclusions

Virus symptoms and the infection levels were more severe in 1979 than in 1978 and 1977, and about the same level as 1976, which had a very high level of virus symptoms at both test sites. In 1979, johnsongrass was not adequately controlled with the herbicide used, and it developed very rapidly. Many hybrids did not compete well with the johnsongrass, which resulted in reduced growth. Low rainfall retarded corn development the first 6 weeks after planting and allowed the johnsongrass to get an early start. Using the mass selection technique for virus tolerance in the PR-Mo2 composite was not effective, and we are considering implementing a change to the ear-to-row method in 1980.

A potential virus threat exists wherever johnsongrass grows; therefore, corn growers should select hybrids with the high levels of virus tolerance. Several of the commercial hybrids tested in 1979 had tolerance levels that should be considered for planting in virus problem areas.

Corn breeders have been quite successful in developing new hybrids with greater tolerances, in fact the number of commercial hybrids with high tolerance levels has increased during the last 9 years.

Virus Tolerance Ratings of Corn Strains Grown in Ohio in 1979¹

William R. Findley, Raymond Louie, John K. Knoke, and Edward J. Dollinger²

Inbred lines and hybrids grown in the Ohio river valley near Portsmouth on the farm of James Daulton were rated for virus disease incidence resulting from natural infection.

Inbred line tests were sponsored by the Ohio Agricultural Research and Development Center (OARDC) and by the North Central Corn Breeding Research Committee (NCCBRC). A hybrid test was conducted cooperatively with OARDC and the Ohio Cooperative Extension Service.

We planted seeds of the corn strains mechanically in replicated plots on May 17 and 18, 1979. Plots were 19 feet (5.8 m) long, in rows 3 feet (91 cm) apart and separated by 3-foot aisles between tiers of plots. Twenty-five seeds of each inbred line were planted in one-row plots. Seeds of the hybrids were planted in two-row plots, 60 seeds per row, and later thinned to 34 plants per row. Inbreds were grown in two replications; hybrids in four replications.

Seedling emergence generally was good resulting in satisfactory stands in nearly all plots. In some plots, however, stands were reduced during the growing season in the processes of roguing and weeding. The weather throughout the season was favorable for corn growth. Except for brief dry periods in mid-June, mid-July, and late August to early September, rainfall was ample to excessive. The corn plants were never under stress from lack of water or extreme heat, but we had difficulty controlling the weeds because of many rainy days.

Virus incidence

Maize dwarf mosaic virus (MDMV) and maize chlorotic dwarf virus (MCDV) infection in trap

plants averaged 41.0 and 5.6 percent, respectively, from late May through August. The susceptible trap plants were potted 14-day old WF9xOh51A seedlings exposed for 7-day periods throughout the growing season.

Average disease incidence of 25 inbred lines included in the 1978 and 1979 tests was 9.2 and 34.7 percent for MDM, and 31.9 and 70.2 percent for MCD, respectively. The average disease ratings for the same 2 years were 2.7 and 4.6, respectively.

Virus disease rating system

We established two systems for evaluating effects of the virus infection. In the first system, we determined disease incidence in the test entry. We observed symptoms of MDM and MCD on individual plants in the OARDC and NCCBRC tests on August 22 and hybrid test on August 3. Symptoms of MDM were chlorotic patterns of mosaic, rings, flecks, streaks, or mottle. The diagnostic symptom of MCD was a chlorotic streaking in the smallest leaf veins. Severe symptoms of one virus often masked symptoms of the other. We assumed that plants dead at rating time were killed by virus infection and were counted as infected with both MDM and MCD.

In the second rating system, we determined disease severity by evaluating the reaction of test entries to virus infection. Ratings were made on the inbred lines on August 8 and the hybrids on August 22. We rated each entry on a plot basis. A virus rating scale that included degrees of stunting and chlorosis ranged from 1 (no visible virus symptoms) to 9 (severe symptoms). Plant stunting was not associated with ratings of 3 or less. Plants rated 2 were faintly chlorotic and those rated 3 were distinctly chlorotic. Ratings of 4 to 9 indicated increasing degrees of stunting and chlorosis and reduction in ear size.

Any combination of mean comparisons are possible with Duncan's New Multiple Range Test. Entries that do not have the same letter in com-

¹Cooperative investigations of USDA-SEA-AR; the Ohio Agricultural Research and Development Center, Wooster; and the Ohio Cooperative Extension Service, Columbus.

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Table 10.—Incidence of maize dwarf mosaic (MDM) in inbred lines in the Ohio Agricultural Research and Development Center test, August 22, 1979, Portsmouth, Ohio

Inbred	MDM-Percent	
JSA52-2	4.2	a ¹
Va94	5.9	ab
AR234	7.1	ab
Oh513	7.2	ab
Ky66-2500	7.3	ab
Mo20W	8.4	ab
Oh5145	12.5	a-c
o ₂ Oh514	12.5	a-c
H95	15.0	a-d
AR230	16.6	a-d
Tx601	17.8	a-e
Oh509Ht	18.0	a-e
Pa405	21.4	a-f
GT3	21.8	a-f
T143	22.2	a-f
N6J	23.2	a-g
N7B	23.8	a-g
Oh509	25.6	a-g
Oh07	29.1	a-h
Oh7B	29.3	a-h
T232	29.4	a-h
AR232	29.4	a-h
Ark381	32.3	a-h
GA209	32.5	a-h
Oh514	33.9	a-i
B79	37.5	a-i
GA203	45.4	a-j
Oh43	50.0	a-k
AR238	54.2	a-k
T240	54.4	a-k
AR224	56.8	a-k
Ark385	58.1	b-k
Pa884P	58.5	b-k
Ark392	62.5	c-k
Ark368D	63.3	c-k
AR222	65.4	c-k
Oh45B	66.6	d-k
Pa32	70.6	e-k
Mo5	72.2	f-k
Oh509A	72.3	f-k
AR220	75.0	f-k
AR240	75.0	f-k
CI. 38B	76.2	g-k
AR226	81.3	h-k
Oh517	86.6	i-k
Va35	93.4	jk
Mo17	93.6	jk
K61-1	95.0	jk
M14	95.9	jk
B54	96.1	jk
Ark380	100.0	k
Oh545	100.0	k
B37	100.0	k
Coefficient of variation	45.4%	
Least significant difference P = .05	43.7	
Mean percent	48.1	

¹Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

Table 11.—Incidence of maize chlorotic dwarf (MCD) in inbred lines in the Ohio Agricultural Research and Development Center test, August 22, 1979, Portsmouth, Ohio

Inbred	MCD-Percent	
T143	30.5	a ¹
Va94	44.8	ab
Mo20W	46.4	a-c
Oh517	49.2	a-d
AR230	51.6	a-e
N6J	51.8	a-e
Ky66-2500	58.3	a-f
Oh7B	58.8	a-f
T232	58.8	a-f
B79	60.0	a-f
JSA52-2	62.5	a-g
Oh5145	65.0	a-g
GT3	66.1	a-g
Oh07	66.6	a-g
GA209	66.8	a-g
Pa884P	67.9	a-g
Tx601	68.8	a-g
T240	70.0	a-g
Oh509A	72.3	b-g
AR220	74.1	b-g
Oh513	74.1	b-g
Mo17	74.6	b-g
Oh45B	77.8	b-g
Oh514	78.6	b-g
H95	80.0	c-g
Ark368D	83.4	c-g
K61-1	85.0	d-g
Pa32	85.3	d-g
Ark381	86.4	e-g
Ark392	87.5	e-g
AR238	87.5	e-g
GA203	88.1	e-g
N7B	89.9	fg
CI. 38B	90.0	fg
Va35	90.0	fg
o ₂ Oh514	90.0	fg
AR224	90.9	fg
Oh509Ht	94.1	g
Mo5	94.4	g
AR240	95.0	g
B54	95.0	g
Oh43	95.4	g
AR234	96.1	g
AR222	96.1	g
Pa405	96.4	g
AR226	96.9	g
Ark385	100.0	g
Ark380	100.0	g
AR232	100.0	g
Oh545	100.0	g
Oh509	100.0	g
M14	100.0	g
B37	100.0	g
Coefficient of variation	20.6%	
Least significant difference P = .05	32.3	
Mean percent	78.3	

¹Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

Table 12.—Virus disease ratings on inbred lines in the Ohio Agricultural Research and Development Center test, August 8, 1979, Portsmouth, Ohio

Inbred	Virus disease rating ¹	
N6J	1.5	a ²
T232	2.5	ab
o ₂ Oh514	3.0	a-c
Va94	3.5	a-d
AR234	4.0	b-e
Pa884P	4.0	b-e
Mo20W	4.0	b-e
Ky66-2500	4.0	b-e
N7B	4.0	b-e
H95	4.0	b-e
Oh509Ht	4.0	b-e
K61-1	4.5	b-f
Oh514	4.5	b-f
JSA52-2	4.5	b-f
GA209	4.5	b-f
T143	4.5	b-f
T240	4.5	b-f
Oh5145	4.5	b-f
B54	5.0	c-g
Ark381	5.0	c-g
Tx601	5.0	c-g
Oh513	5.0	c-g
Oh7B	5.0	c-g
Pa405	5.0	c-g
AR232	5.0	c-g
GA203	5.0	c-g
GT3	5.0	c-g
Oh509A	5.0	c-g
Oh517	5.0	c-g
Oh509	5.5	d-g
Mo17	5.5	d-g
Oh07	5.5	d-g
Oh45B	6.0	e-h
Pa32	6.0	e-h
Ark380	6.0	e-h
AR224	6.0	e-h
B79	6.0	e-h
AR220	6.0	e-h
AR240	6.5	f-i
AR238	6.5	f-i
AR230	6.5	f-i
Ark392	7.0	g-j
CI.38B	7.0	g-j
Ark368D	7.0	g-j
AR226	7.0	g-j
AR222	7.0	g-j
Ark385	8.0	h-j
Oh43	8.0	h-j
B37	8.0	h-j
Oh545	8.5	i-j
Mo5	8.5	i-j
Va35	9.0	j
M14	9.0	j
Coefficient of variation	17.5%	
Least significant difference	1.9	
Mean rating	5.5	

¹Virus disease rated on a 1 to 9 scale, with 1 = no symptoms and 9 = severe symptoms.

²Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

Table 13.—Incidence of maize dwarf mosaic (MDM) in inbred lines in the North Central Corn Breeding Research Committee uniform test, August 22, 1979, Portsmouth, Ohio

Inbred	MDM-Percent
Oh7B	3.8 a ¹
Pa73-5	25.0 ab
Mo28W	28.5 a-c
Pa69-19	30.0 a-d
B85	45.0 a-e
H101	45.8 a-f
Mo27W	47.4 a-g
Mich. 78-3	48.2 b-h
Mo31W	55.0 b-i
Mo17	56.3 b-i
W64A	57.1 b-i
Oh8723	57.9 b-i
MS76	66.1 b-i
Pa69-8	67.0 b-i
Oh43	67.3 b-i
Mo36	67.9 b-i
Pa69-7	70.5 b-i
Pa73-1	71.9 c-i
A666	73.7 c-i
B14	73.8 c-i
Pa69-20	75.0 d-i
Pa75-24	83.3 e-i
B84	83.3 e-i
SD525-263	83.9 e-i
Pa75-30	84.3 e-i
Mich. 78-1	84.6 e-i
W117	88.2 e-i
B37	88.5 e-i
ND76-8	89.5 e-i
MS75	92.3 f-i
ND76-1	92.9 g-i
Mich.78-2	93.3 g-i
W153-R	94.1 h-i
Pa73-3	94.7 i
B73	97.5 i
ND78-10	100.0 i
Mich.78-4	100.0 i
B86	100.0 i
Coefficient of variation	26.8%
Least significant difference P = .05	38.3
Mean percent	70.6

¹Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

mon differ at the 5 percent probability level. We computed least significant differences (LSD) at the 5 percent probability level and also coefficient of variation (CV) values. The LSD is useful in comparing entries with a common standard or adjacent means. The CV is a good indicator of test uniformity: the lower the CV the greater the degree of test uniformity.

Table 14.—Incidence of maize chlorotic dwarf (MCD) in inbred lines in the North Central Corn Breeding Research Committee uniform test, August 22, 1979, Portsmouth, Ohio

Inbred	MCD-Percent
Oh7B	23.8 a ¹
H101	28.3 a
Mo28W	57.3 b
Mich.78-3	58.8 bc
Mo27W	63.6 b-d
B85	68.4 b-e
Pa73-5	70.8 b-e
Pa69-7	71.4 b-e
Mo36	75.0 b-e
Pa73-1	78.1 b-e
ND76-8	78.9 b-e
Mo17	79.8 b-e
B14	80.0 b-e
B37	80.8 b-e
Pa69-20	81.3 b-e
Pa69-8	82.1 b-e
B84	85.0 b-e
ND76-1	85.7 b-e
Pa69-19	87.5 b-e
Oh8723	88.5 b-e
MS76	89.7 b-e
Mich.78-2	90.0 b-e
W117	91.2 c-e
Mich.78-1	92.3 c-e
Pa75-30	92.9 de
SD525-263	93.8 de
W64A	93.9 de
Pa73-3	94.7 de
B86	95.5 de
ND78-10	96.2 de
MS75	96.4 de
Mich.78-4	96.4 de
B73	97.5 e
W153-R	100.0 e
A666	100.0 e
Pa75-24	100.0 e
Oh43	100.0 e
Mo31W	100.0 e
Coefficient of variation	16.6%
Least significant difference P = .05	27.7
Mean percent	82.7

¹Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

Inbred evaluation

Percentages of plants with MDM and MCD and mean plot virus disease ratings of the 53 lines in the OARDC test are shown in tables 10, 11, and 12, respectively. Many of the inbreds were tested in several previous years. Inbreds N6J and T232 appeared to have an acceptable level of virus tolerance, however, these lines had 23.2 and 29.4 percent MDMV-infected plants and 51.8 and 58.8 percent MCDV-infected plants, respectively. Inbred Va94 was statistically equal to N6J and T232 in disease incidence and virus disease rating.

Table 15.—Virus disease ratings on inbred lines in the North Central Corn Breeding Research Committee uniform test, August 8, 1979, Portsmouth, Ohio

Inbred	Virus disease rating ¹
H101	2.5 a ²
Oh7B	3.5 ab
Mo28W	4.0 a-c
ND76-1	4.5 a-d
Pa73-5	4.5 a-d
Mo27W	5.0 b-e
Mich.78-3	5.0 b-e
SD525-263	5.5 b-f
ND76-8	5.5 b-f
B85	6.0 c-g
W117	6.0 c-g
B14	6.0 c-g
Pa69-19	6.0 c-g
Mo17	6.0 c-g
Pa73-3	6.0 c-g
Pa69-8	6.5 d-h
Pa69-20	6.5 d-h
A666	6.5 d-h
Oh8723	6.5 d-h
B37	6.5 d-h
MS76	7.0 e-h
B73	7.0 e-h
Mich.78-2	7.0 e-h
B84	7.0 e-h
Mo36	7.5 f-h
ND78-10	7.5 f-h
Pa75-30	7.5 f-h
Pa75-24	7.5 f-h
Pa69-7	7.5 f-h
Mo31W	7.5 f-h
Mich.78-1	7.5 f-h
MS75	7.5 f-h
W64A	7.5 f-h
Oh43	7.5 f-h
Pa73-1	7.5 f-h
B86	8.0 g-h
W153R	8.5 h
Mich.78-4	8.5 h
Coefficient of variation	14.4%
Least Significant difference P = .05	1.9
Mean percent	6.4

¹Virus disease rated on a 1 to 9 scale, with 1 = no symptoms and 9 = severe symptoms.

²Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

Percentages of plants with MDM and MCD and mean plot virus ratings of the 38 lines in the NCCBRC test are shown in tables 13, 14, and 15, respectively. Except for the standard inbreds (W117, W153R, Oh43, W64A, B14, B37, B73, Mo17, and Oh7B), the entries were advanced experimental lines from various states. Inbred H101 had the lower virus disease rating, however, it had 45.8

Table 16.—Incidence of maize dwarf mosaic (MDM) in commercial and open-pedigree hybrids, August 3, 1979, Portsmouth, Ohio

Hybrid	MDM-Percent
Oh514xOh7714132	0 a ¹
Funk G-4787W	.4 a
Oh6526xOhBB05	.4 a
Oh514xOh7714501	.5 a
Oh509AxOhS2-#4/-S-#-S4/	.5 a
Oh5145xOh509A	.8 ab
Stewart SX77M	1.2 ab
A632xOhS2-#4/-S-#-S4/	1.3 ab
Zimmerman Z30	1.6 ab
(H95xH99)xOh7B	1.6 ab
Landmark C788XX	2.0 ab
(B54xKy66-2500)-S3/xOh509A	2.0 ab
(B54xKy66-2500)-X3/x873	2.5 ab
Madison MDM1	2.9 ab
Landmark Exp. 2956	2.9 ab
Landmark C787XX	3.2 ab
Northrup-King PX79	3.4 ab
Ruffs R-434	3.4 ab
Taylor-Evans T-E6945	3.5 ab
(Oh7BxOh07)xH95	3.7 ab
Funk G-4740	3.7 ab
P-A-G SX17A	3.9 ab
Funk G-4525	3.9 ab
H95xOh7714132	4.0 ab
Funk 2B793	4.1 ab
Pioneer brand 3145	4.2 ab
Madison Exp. AAT	4.2 ab
O's Gold SX5255	4.4 a-c
O's Gold Exp. 5535	4.6 a-c
Northrup-King PX95	4.9 a-d
O's Gold SX-3344	4.9 a-d
Trojan MDM116	5.1 a-d
Zimmerman Z31	5.3 a-d
P-A-G 266010	5.3 a-d
Pioneer brand 3147	5.8 a-d
Pioneer brand X7448	6.5 a-d
P-A-G SX346	6.5 a-d
Kenworthy KL-X73	6.6 a-d
Taylor-Evans T-E6947	6.8 a-d
Akin XA3999	7.1 a-d
(Oh7BxMo12) (CI. 38BxVa35)	7.1 a-d
Zimmerman Z11W	7.3 a-d
Stewart SXB1M	7.7 a-d
Madison Exp. MT	8.2 a-d
(Oh509AxOh7Bht)xH95	8.4 a-d
Acco UC9792	8.7 a-d
Kenworthy KL-X74	8.8 a-d
Cargill 951	9.0 a-d
Andersons X611	9.9 a-e
(Oh509AxOh514)xH95	9.9 a-e
Ruffs R-444	10.3 a-e
Baldrige RX335	10.7 a-e
Funk 29114	11.3 a-e
Zimmerman Z52W	11.4 a-e
Pioneer brand 3179	12.6 a-e
Baldrige RX77	12.9 a-e
O's Gold TX-311	13.1 a-e
Akin XA390B	14.0 b-e
DeKalb XL72B	14.0 b-e
O's Gold Exp. 5291	17.4 c-f
Funk G-484B	18.1 d-f
O's Gold Exp. 674B	18.1 d-f
Hiser 773	22.7 e-g
Mol7xOh7714501	29.0 f-h
Baldrige RX24	29.1 f-h
Baldrige RX647	31.4 gh
Acco UC8951	33.9 gh
Kenworthy KL-X77	35.1 h
P-A-G 266031W	36.2 h
Baldrige RX44	37.9 h
O's Gold SX5353	51.7 i
WF9xOh51A	80.2 j
Coefficient of variation	70.8%
Least Significant difference P = .05	10.6
Mean percent	10.8

¹Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

Table 17.—Incidence of maize chlorotic dwarf (MCD) in commercial and open-pedigree hybrids, August 3, 1979, Portsmouth, Ohio

Hybrid	MCD-Percent
Zimmerman Z30	6.0 a ¹
(Oh509AxOh78Ht)xH95	10.5 ab
Stewart SX77M	11.0 ab
A632xOhS2-#4/-S-#-S4/	12.8 a-c
Landmark C788XX	13.1 a-c
Oh514xOh7714132	14.1 a-d
H95xOh7714132	15.3 a-e
Madison MDM1	15.9 a-e
Oh514xOh7714501	16.5 a-f
(Oh509AxOh514)xH95	17.0 a-f
Funk G-4525	17.3 a-g
Landmark C787XX	17.4 a-g
Taylor-Evans T-E6945	17.4 a-g
Ruffs R-434	21.1 a-h
Trojan MDM116	21.1 a-h
Acco UC9792	21.3 a-h
(Oh78xOh07)xH95	21.8 a-i
Kenworthy KL-X73	21.8 a-i
Oh509AxOhS2-#4/-S-#-S4/	23.4 a-j
Kenworthy KL-X74	24.5 a-j
O's Gold Exp. 5535	25.5 a-k
Funk 28793	25.6 a-k
(H95xH99)xOh7B	27.3 a-l
Funk G-4848	27.4 a-l
P-A-G SX17A	27.7 a-m
O's Gold SX3344	28.5 a-n
Ruffs R-444	29.4 a-n
O's Gold SX5255	29.7 a-n
Funk G-4740	30.2 b-n
Funk G-4787W	30.2 b-n
Pioneer brand 3179	30.2 b-n
Andersons X611	30.3 b-n
Pioneer brand X7448	30.3 b-n
Akin XA3908	30.5 b-n
Pioneer brand 3147	31.1 b-n
Zimmerman Z31	31.5 b-n
Akin XA3999	31.6 b-n
Oh5145xOh509A	31.7 b-n
Mol7xOh7714501	32.2 b-n
Madison AAT	33.8 b-n
Landmark Exp. 2956	33.9 b-n
P-A-G 266010	36.0 c-o
Zimmerman Z11W	38.0 d-p
DeKalb XL72B	38.4 e-p
Oh6526xOh8805	40.1 f-p
O's Gold Exp. 5291	41.0 g-p
Stewart SX81M	41.5 h-q
Northrup-King PX79	42.2 h-q
Baldrige RX335	43.2 h-q
(Oh78xMo12) (CI. 38BxVa35)	43.3 h-q
Northrup-King PX95	43.6 h-q
Zimmerman Z52W	44.1 h-q
O's Gold TX-311	44.8 h-q
O's Gold Exp. 6748	45.3 i-q
Pioneer brand 3145	45.4 i-q
Cargill 951	46.2 j-q
Madison Exp. MT	47.2 j-r
Hiser 773	49.3 k-r
Baldrige RX77	49.8 l-s
Acco UC8951	51.5 m-t
Funk 29114	52.0 n-t
(854xKy66-2500)-S3/xB73	52.2 n-t
Kenworthy KL-X77	57.9 o-t
P-A-G 266031W	58.7 o-t
Baldrige RX647	59.5 o-t
(854xKy66-2500)-S3/xOh509A	59.5 o-t
Baldrige RX24	59.6 o-t
P-A-G SX346	60.5 p-t
Taylor-Evans T-E6947	65.1 q-t
O's Gold SX5353	70.4 r-t
WF9xOh51A	72.6 st
Baldrige RX44	74.0 t
Coefficient of variation	39.0%
Least significant difference P = .05	19.1
Mean percent	35.3

¹Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

Table 18.—Virus disease ratings on commercial and open-pedigree hybrids, August 22, 1979, Portsmouth, Ohio

Hybrid	Virus disease rating ¹		Hybrid	Virus disease rating ¹	
Zimmerman Z30	1.0	a ²	P-A-G SX17A	2.4	a-j
(Oh7BxOh07)xH95	1.3	ab	Acco UC9792	2.4	a-j
Stewart SX77M	1.3	ab	Zimmerman Z52W	2.4	a-j
Madison Exp.AAT	1.4	a-c	Cargill 951	2.4	a-j
Pioneer brand X7448	1.4	a-c	Ruffs R-434	2.5	b-k
Landmark C788XX	1.4	a-c	Mol7xOh7714501	2.6	b-l
H95xOh7714132	1.4	a-c	O's Gold SX-5255	2.6	b-l
Madison MDM1	1.4	a-c	P-A-G SX346	2.6	b-l
Zimmerman Z31	1.4	a-c	Kenworthy KL-X73	2.6	b-l
Funk G-4525	1.5	a-d	Madison Exp. MT	2.8	c-l
Taylor-Evans T-E6945	1.5	a-d	Akin XA3999	2.8	c-l
Oh514xOh7714501	1.6	a-e	(Oh7BxMo12) (Cl.38BxVa35)	2.9	d-m
Pioneer brand 3147	1.6	a-e	Pioneer brand 3145	2.9	d-m
Oh514xOh7714132	1.6	a-e	Funk 29114	2.9	d-m
Landmark C787XX	1.6	a-e	Northrup-King PX95	2.9	d-m
Oh509AxOhS2-#4/-S-#-S4/	1.8	a-f	(B54xKy66-2500)-S3/xB73	3.0	e-m
Funk G-4787W	1.8	a-f	Stewart SX81M	3.1	f-n
(Oh509AxOh7BHt)xH95	1.8	a-f	DeKalb XL72B	3.3	g-o
Oh6526xOh8805	1.8	a-f	Baldrige RX335	3.4	h-o
Ruffs R-444	1.9	a-g	Hiser 773	3.5	i-p
Kenworthy KL-74	1.9	a-g	(B54xKy66-2500)-S3/xOh509A	3.6	j-q
Funk G-4848	1.9	a-g	O's Gold TX311	3.6	j-q
Funk G-4740	2.0	a-h	Taylor Evans T-E6947	3.9	k-r
Zimmerman Z11W	2.0	a-h	O's Gold Exp. 6748	3.9	k-r
Landmark Exp.2956	2.0	a-h	Baldrige RX77	4.0	l-r
Funk 28793	2.0	a-h	O's Gold Exp. 5291	4.0	l-r
Akin XA3908	2.0	a-h	O's Gold SX5353	4.3	m-s
Pioneer brand 3179	2.0	a-h	Baldrige RX24	4.5	n-s
(Oh509AxOh514)xH95	2.1	a-i	Baldrige RX647	4.6	o-s
Oh5145xOh509A	2.1	a-i	Acco UC8951	4.6	o-s
(H95xH99)xOh7B	2.1	a-i	P-A-G 266031W	4.9	p-s
A632xOhS2-#4/-S-#-S4/	2.1	a-i	Kenworthy KL-X77	5.0	q-s
O's Gold SX-3344	2.1	a-i	Baldrige RX44	5.3	r-s
Northrup-King PX79	2.3	a-j	WF9xOh51A	5.5	s
Andersons X611	2.3	a-j			
Trojan MDM116	2.3	a-j	Coefficient of variation	33.1%	
P-A-G 266010	2.3	a-j	Least significant difference P=.05	1.2	
O's Gold Exp.5535	2.4	a-j	Mean percent	2.6	

¹Virus disease rated on a 1 to 9 scale, with 1 = no symptoms and 9 = severe symptoms.

²Duncan's Multiple Range Test--Entries with the same letter in common are not considered significantly different at the 5 percent level.

and 28.3 percent MDMV- and MCDV-infected plants, respectively. Inbred Oh7B was the only inbred statistically equal to H101 in disease incidence and virus disease rating.

Hybrid evaluation

Results of the hybrid test are reported in tables 16, 17, and 18 for percentages of MDMV- and MCDV-infected plants and mean plot virus ratings, respectively. We included 56 (available and experimental) proprietary hybrids and 16 open-pedigree combinations. Many of the hybrids had good virus disease ratings but relatively few had low percentages of MCDV-infected plants.

Conclusions

The virus disease in southern Ohio is known to be caused by MCDV and several strains of MDMV, and reaction of corn strains to these viruses is related to their degree of tolerance. A high degree of tolerance to MDMV is more common than to MCDV.

The host response of susceptible hybrids in the presence of low disease potential can be severe, but host responses of the more tolerant hybrids may require a stress condition to interact with virus infection to induce stunting and chlorosis. Even in highly tolerant hybrids, a few individual plants may appear to be severely stunted and chlorotic from virus infection.

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